artery and vein. Ligation of the fistula will restore continuity of both artery and vein.

Type 2. Small opening in artery, large tear in the vein, producing a sac at the expense of the vein. In this type the best treatment is obliterative aneurysmorrhaphy, restoring continuity of the artery.

Type 3. Large hole in both vein and artery with two openings into the sac for both artery and vein. This type should be treated by aneurysmorrhaphy.

Type 4. The aneurysm is at the site of arterial bifurcation with two or three arterial openings into the sac. This type is best treated by aneurysmorraphy with closure of the various arterial openings from within the sac.

My own experience in this lesion has been limited to two cases. One case was that of a Mexican boy, age sixteen, who was shot in the inner aspect of his left thigh. He was in shock for a time but recovered, went on about his business and was perfectly all right. Three or four months afterward he had swelling and pain in the left leg which was so distressing that he came to the hospital. There was a large, blowing murmur over the femoral artery, with every evidence of aneurysm. I exposed this, sutured the artery and ligated the vein. He made an uneventful recovery.

Another case was that of a boy who was shot in the popliteal space of the left leg, and the bullet coursed down the anterior aspect of the leg. He developed a large pulsating tumor, with a bruit in the popliteal space. In this case we were able by going well above the vein to ligate the artery.

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EDGAR L. GILCREEST, M. D. (384 Post Street, San Francisco).—This valuable contribution of Doctor Holman adds much to our present knowledge of the physiologic effects of abnormal communications between arteries and veins. The conclusions which he draws from his experiments are logical and conclusive.

It was my good fortune to have recently a clinical case, a traumatic subclavian arteriovenous aneurysm of eight years' duration which came to operation. The study of this case before and after operation presents important clinical data proving the experimental observations so clearly advanced by Doctor Holman.

The diagnosis of this case was based on the following points:

1. Great swelling of the right chest, right shoulder girdle and entire right arm and hand.
2. Enormous distention of veins in these parts.
3. Cardiac dilatation and hypertrophy.
4. Branham's bradycardiac reaction and associated blood pressure variations.
5. A continuous purring thrill over the distal veins.
6. A continuous bruit, accentuated during systole, over the distal veins.
7. The centrifugal transmission of the thrill and bruit.
8. An increase of the oxygen content in the venous blood distal to the lesion.

At operation the proximal artery and veins, as pointed out by Doctor Holman in his experiments, were found to be dilated, as well as the distal vein. Proximal ligations of artery and veins improved, but did not effect a cure. Subsequent distal ligations of arteries and veins, ten months later, completing the quadruple ligation, effected a complete cure—all of which confirm the conclusions so ably presented by Doctor Holman in this splendid paper. It might be interesting to enumerate the various ligations which were made in this two-stage operation. First operation: Ligation of external and internal jugular, subclavian and innominate veins and the subclavian artery. Second operation: Ligation of axillary vein, subclavian, axillary and long thoracic arteries, making in all a total of nine ligations.

In the treatment of this case, therefore, the principles enunciated by Doctor Holman in this article were carried out with the exception that it was performed in two stages instead of one. I have no hesitancy in stating that I believe by the ligation at the first operation of the proximal vein, in this case the innominate, gangrene of the fingers was prevented.

TORSION OF THE SPERMATIC CORD

By R. P. ROANTREE, M. D.
Elko, Nevada

DISCUSSION *by W. P. Willard, M. D., San Francisco; Miley B. Wesson, M. D., San Francisco; William E. Stevens, M. D., San Francisco.*

TORSION of the spermatic cord is not extremely rare. Prior to 1920 only one hundred and twenty cases had been recorded in the literature. Since that time twenty-five additional cases have been added, and of these, fifteen have been reported by Campbell [1] from Bellevue Hospital. The writer has seen two cases in the past year in a small town practice.

In writing on this subject de Quervain [2] says: "The only condition with which it could be possibly mistaken is an embolic infarction of the testicle occurring in a patient with heart disease." In apparent contradiction to this statement Young [3] writes: "The diagnosis of torsion of the cord is often missed." This discrepancy between two authorities can only be explained either by the fact that the condition is not known or because its frequency is not realized.

Torsion of the spermatic cord, as its name implies, is an axial rotation of all the cord structures and the testicle with a resulting impairment or total loss of blood supply beyond the point of torsion. An obstruction to the venous return results, with infarct formation in the testicle and in the cord distal to this occlusion. The twist may occur either within or outside of the tunica vaginalis.

Torsions occurring in the extravaginal portion are extremely rare because all the connections between the external surface of the tunica vaginalis and the tissue surrounding it must be broken. It is interesting to note in this connection that in certain countries this method of castration of lower animals has been used under the name of "bistournage." The operator of "bistourneur" manipulates the testicle, breaking loose its connections, and rotates it to produce an artificial torsion which is followed by gangrene.

Intravaginal torsion of the cord is much more frequent than extravaginal. As a rule the torsion occurs immediately above the testicle. In the normally developed individual the testis and the epididymis are closely attached to each other and the epididymis is attached to the scrotal parietes over at least four-fifths of its length. This makes intravaginal torsion impossible in the normal individual. Torsion is only possible when the connection between the testis and the epididymis, or epididymis and scrotum are extremely loose and mobile. In one of our patients the testicle hung from a pedicle one inch long and one-fourth inch in diameter. Torsion is about as frequent in the scrotal as in undescended testicles. The percentage of cryptorchids in the general population is very low, hence the percentage of torsion occurring in imperfectly descended testicles must be higher than in scrotal testicles.

Sudden cremasteric contraction has been emphasized as the immediate cause of torsion. This must be considered since the onset of some torsions occurs during sleep. The usual history is

that the torsion followed violent muscular effort with straining or injury to the scrotum.

Torsion may occur at any age. It has been observed in infants and in old age, but is most frequent in early adult life.

SYMPTOMS AND SIGNS

The onset of torsion of the cord is always sudden. Severe pain is a constant accompaniment and may be localized in the affected side of the scrotum, or referred to the abdomen and accompanied by temporary obstruction to the passage of motions and flatus, and even by prostration. In simple torsion the temperature is rarely above 100 degrees Fahrenheit, but may reach 104 degrees Fahrenheit. The scrotum swells rapidly and is so extremely tender that it is impossible to differentiate the epididymis from the testis. The swelling is at first confined to the testicle, but later the scrotal tissues become edematous and the skin somewhat discolored. This discoloration of the skin may extend well past the midline. Indications of fluid within the tunica vaginalis may be found. The opposite testicle may give evidence of abnormal motility. In one case rhythmical contraction and relaxation of the cremasteric was noted thirty hours after the onset of the condition. The rate was thirty per minute, and it continued throughout the entire examination. This was not noted at other examinations.

DIFFERENTIAL DIAGNOSIS

In the differential diagnosis the position of the testicle has to be taken into consideration. The presence of classical symptoms in a descended testicle with no history of direct injury must be either an epididymitis or torsion of the spermatic cord. The onset of epididymitis is more gradual, and the finding of a prostatic or urethral discharge containing pus should suffice for the diagnosis. With a history of direct injury, traumatic hematocele must be considered. The before mentioned findings will differentiate between torsion of the cord and epididymitis; but it must not be forgotten that epididymitis can occur after an injury. In traumatic hematocele the onset is more gradual than in torsion and more rapid than in epididymitis. The pain increases in severity with the increase in the size of the scrotum. The scrotum is as a rule much larger, and often an ecchymotic area may be found on the posterior surface.

When the testicle is in the inguinal canal, acute hydrocele, neoplasm, appendicitis, strangulated hernia, and torsion of the spermatic cord are to be considered. Acute hydrocele is usually easily ruled out, as it is a tense, well-defined swelling that does not enter the inguinal canal. It occurs only in infants and is not accompanied by distention, retention of flatus, or vomiting. It transmits light, and a needle will verify the diagnosis.

A neoplasm may give rise to similar symptoms and should be considered, that the surgeon may be prepared for a complete removal of the involved tissues.

When the condition arises upon the right side appendicitis may be simulated. Appendices, especially in children, have been found within hernial sacs. The onset of appendicitis is usually slower, with vomiting following some time after the onset of pain. Vomiting is more prolonged and there may be no retention of flatus or feces. The pulse as a rule is more rapid and leukocytes are increased in appendicitis.

The diagnosis between torsion and strangulated hernia is at times impossible. Most undescended testes are accompanied by hernia, and the history of a previous hernia may be an aid. As a rule retention of flatus and feces is not so marked in torsion and passes off after a short time. However, immediate operation is indicated to save the involved structure whether it be testicle, appendix, or intestine.

Attempts have been made to relieve this condition manually by untwisting the cord. This technique has been successful in a few cases, but is unsatisfactory since the direction of the primary twist cannot be previously demonstrated. Atrophy occurs in testes which are not relieved within one hour after torsion, and gangrene begins within forty-eight hours. Operation will save many testes if done early, but they will probably often atrophy. In cases where a long pedicle on an involved scrotally contained testicle is found, the opposite side should be examined for abnormal motility of the testicle. Should the other testicle give evidence of a long gubernaculum, it also should be fixed to the bottom of the scrotum as several instances of bilateral occurrence have been reported.

If the testicle is viable the tunica vaginalis should be inverted to prevent hydrocele, and the testicle sutured to the bottom of the scrotum to prevent recurrence. If gangrene has supervened, as evidenced by lack of bleeding, a black discoloration and bulging of a black clot on incision of the visceral tunica vaginalis, orchidectomy must be done.

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2. de Quervain, F.: Clinical Surgical Diagnosis, 1926, p. 513.

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DISCUSSION

W. P. Willard, M. D. (384 Post Street, San Francisco).—Doctor Roantree has, through his paper brought to our attention a condition that should be kept in mind by every industrial surgeon. For it is among men doing heavy work that the condition is most apt to appear. Doctor Roantree has within a few months seen two cases in the course of his general surgical work. I have seen but one case in over twenty years of urological work.

Miley B. Wesson, M. D. (1275 Flood Building, San Francisco).—Torsion of the testicle occurs rather infrequently but, like Doctor Roantree, we are beginning to wonder if its rarity is not more apparent than real, the condition not being recognized either before or after operation for "gangrene of the testicle."

The predisposing cause of torsion is an undue mobility of the testicle and it is commonly associated with incomplete descent of this organ into the scrotum, at least to the extent of an unusual length of gubernaculum. The first report of a case of torsion was by Delasiuave in 1840. Operation was done for a supposedly strangulated hernia and torsion of an inguinal testicle found. Then, at intervals, isolated cases have

been reported. Nicoladani in 1885 called attention to the fact that the undescended testicle is more liable to rotation of its pedicle with torsion and subsequent strangulation than the normally descended organs. Scudder in 1901 compiled thirty-two cases of torsion of the pedicle; 47 per cent of these occurring in undescended testicles. In 1927 Ormond reported six cases of torsion of intra-abdominal testicles in three of which the testis was the site of a malignant tumor.

In every case a congenital malformation or anomaly exists, and trauma is a negligible factor. The testicle is not attached properly to the walls of the scrotum, but hangs loosely like a pendulum within the scrotal sac. If the patient makes a lateral motion and then stops suddenly, the heavy testicle, hanging by the vas and not anchored securely to the wall of the scrotum, may rotate too far and even twist three or four times and stay in this position. The superficial veins are obstructed and, since the uninfected arteries continue to pour in blood, the whole testicle soon resembles a blood-clot. Everything below the twist is turned into a hemorrhagic infarct. If the condition is treated conservatively the extravasated blood will absorb and eventually the scrotum will return to normal, but the testis will atrophy. No normal man can possibly have a torsion of the testicle without intentional scrotal manipulation (bistournage) has been carried out, but one with an appropriate congenital defect in his scrotum is liable to have a torsion of the testicle any time he moves whether it be turning over in his sleep, walking fast and then stopping suddenly, or throwing an orange box up on top of a pile, as in the following characteristic case.

A man was stacking orange boxes on end. He had already placed one box on top of the other and as he attempted to throw the third box up he lost his balance, the box falling over his shoulder and throwing him forward; he felt a nauseating pain at the time, which was very severe for twenty-four hours, then gradually subsided. On the evening of the accident his testicle was swollen. Six days later the surgeon diagnosed "gangrene of the testicle due to trauma" and an orchidectomy was done. The pathologist reported "infarct of the testicle."

It is very unfortunate that Doctor Roantree did not report in detail his two cases so that they could be incorporated in the literature of this subject. He has very aptly called attention to the fact that the diagnosis of torsion of the testicle may readily be made by one who is on the lookout for it, and the fact that two cases have been recently observed in one man's practice in a town of less than three thousand bears out this view.

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William E. Stevens (608 Flood Building, San Francisco).—It is interesting to note that Doctor Roantree has seen two cases of torsion of the spermatic cord in his general practice. Many urologists have never seen one.

Although there may be a twist of from one-quarter to two or more complete turns the condition rarely, if ever, occurs in the presence of normal testicular attachments. Trauma is not necessarily an etiologic factor, as the condition may occur while the patient is lying in bed. About half of these twists are seen in patients with undescended testicles.

Torsion of the spermatic cord is to be differentiated from acute epididymitis and, if the testicle is undescended, from strangulated hernia. There is less pain but more general disturbance accompanying the latter, and the temperature is not elevated. In the presence of epididymitis the prostate and seminal vesicles are usually involved and pus is found in the urine. The enlarged, tender epididymis can usually be differentiated from the testicle.

If seen very early an attempt to untwist the cord is sometimes successful although atrophy of the testicle usually occurs. Even if in the scrotum atrophy follows conservative treatment. As Doctor Roantree has stated, a gangrenous testicle should be removed.

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R. P. Roantree, M. D. (Elko, Nevada).—Abnormal mobility of the testicle is the cause of torsion of the spermatic cord, and is well illustrated in one of my cases. A boy was seen September 11, 1926, complaining of pain and swelling in the right scrotum. The pain began suddenly about 5 p. m., after playing baseball. The patient had taken a hot bath, which caused the pain to become more severe. Examination at 6 p. m. disclosed the right testicle to be two times average size and the structures could not be identified because of tenderness. He was given acetylsalicylic acid, but this would not control the pain and at 7 p. m. he was given morphia, grain one-sixth, subcutaneously. This controlled the pain until 11 p. m., when a second injection of morphia was required. The patient got out of bed the following day and the next day returned to school. The condition caused no further trouble and he did not report at my office as requested.

On March 13, 1927, the same boy was seen complaining of severe pain and swelling in the left scrotum. This attack began forty-five minutes after he had gone to sleep. The pain was very severe and required morphia. The testicle was two times average size, red and exquisitely tender. On March 15, 1927, the testicle was about the same size, the skin more edematous but the pain less severe. A rhythmical contraction and relaxation of the left cremasteric muscle with a rate of thirty per minute was noticed at this time. On March 18, 1927, the scrotum was of the same size, very red and edematous.

Torsion of the right spermatic cord was not diagnosed till after the torsion had relieved itself. When the parents were informed that the condition of the left side was similar to that which had occurred on the right side, consent to operate could not be obtained. They believed that the condition would relieve itself, and this accounts for the infrequent visits and the delay in removing the gangrenous testicle. At operation on March 18, 1927, the left testicle was twisted one and one-half complete turns to the left and was gangrenous distal to the twist in the spermatic cord. The right tunica vaginalis was opened. The testicle hanging from its long thin pedicle resembled a cherry hanging by its stem. The long thin pedicles, which were undoubtedly similar on both sides, accounts for susceptibility to torsion of the spermatic cord. The more severe torsion occurred during sleep when no trauma or muscular action was evident.

COMPARATIVE ANATOMY OF THE BILIARY SYSTEM*

WITH ILLUSTRATIVE DRAWINGS BY SAXTON TEMPLE POPE, M. D.

By Stanley H. Mentzer, M. D.
San Francisco

Discussion *by Wallace I. Terry, M. D., San Francisco.*

EXPLANATORY NOTE

IN his extraordinary hunting expedition with the bow and arrow into the heart of Africa, the late Dr. Saxton Pope carried with him also a zeal for medical knowledge that bore unusual fruit.

At the suggestion of Dr. Wallace I. Terry of the University of California, Doctor Pope took the drawings and descriptions of the biliary tracts of animals that I had been able to gather, with him into Africa. The biliary tracts of many animals have not been described, and it was our ambition to add new chapters to such data in the hope that new material might enhance our study of the physiology of the bile tract in the human. Doctor Pope succeeded beyond our fondest expectations, bringing back twenty-six drawings,

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